

# **Kwethluk River Counting Tower Salmon Assessment Project, 1999**

By

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## ABSTRACT

In 1996 the Association of Village Council Presidents (AVCP) in cooperation with the Alaska Department of Fish and Game (ADF&G) and the U.S. Fish and Wildlife Service (USFWS) initiated and operated a salmon counting tower on the Kwethluk River, a tributary of the lower Kuskokwim River. Funding was renewed in 1997, 1998 and 1999 to continue the project. This report presents the results of the counting tower operations in 1999.

The 1999 counting operation began on 15 July and ended on 18 August. Passing salmon were counted the first 20 min of each hour, 24 h a day. Daily salmon passage by species was estimated by multiplying the daily sum of the 20 min counts by three. The total estimated passage during the operational period was 873 chinook, 234 sockeye, 702 chum, 678 pink, and 693 coho. The operational period was truncated, mostly due to operational difficulties, thus producing salmon passage estimates representing an unknown fraction of the total escapement.

High and murky water levels in the Kwethluk River delayed the onset of operations by 24 days at the start of the season. On advise of ADF&G and BSFA, the project was discontinued 19 days earlier than the planned termination date in order to save money for other projects. As in 1998, the 1999 tower operations comprised only a fraction of the total passage of each salmon species. The limited passage estimates were useful mostly in the context of comparing daily passage estimates in 1999 to the estimates of 1992, 1996, 1997 and 1998.

Overall, the chinook, chum, pink and coho passages all appeared to be relatively low in 1999. Sockeye salmon have a naturally low incidence in the Kwethluk River and the numbers observed in 1999 appeared comparable to past years. To adequately assess coho and pink salmon escapements, the tower must operate until at least mid-September; however, this is not a realistic expectation for the tower due to chronically poor counting conditions in August and September. Although species identification by the tower crew did not appear to be a significant problem, any future tower operations should include an evaluation of the crew's variability in salmon identification.

## INTRODUCTION

The Kwethluk River originates in the Kilbuck Mountains and flows for approximately 220 km to the Kuskokuak Slough of the Kuskokwim River (Brown 1983). The river drains an area of about 3,400 km<sup>2</sup>, most of which is within the Yukon Delta National Wildlife Refuge and managed by the U.S. Fish and Wildlife Service (USFWS). The mouth of the Kwethluk River, where the village of Kwethluk (population ~650) is located, is about 170 km from the mouth of the Kuskokwim River. The lower 5 km of the Kwethluk River is tidally influenced.

Chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), sockeye (*O. nerka*), coho (*O. kisutch*), and pink salmon (*O. gorbuscha*) spawn in the Kwethluk River. Common resident species include rainbow trout (*O. mykiss*), Dolly Varden (*Salvelinus malma*), Arctic grayling (*Thymallus arcticus*), burbot, or “lush” (*Lota lota*), northern pike (*Esox lucius*), and whitefish (*Coregonus spp.*).

Subsistence and commercial fishers who live along the Kuskokwim River place major cultural and economic importance on the harvest of salmon. Commercial fisheries occur in two non-contiguous districts (Districts 1 and 2) in the Kuskokwim River stretching from the river mouth to Chuathbaluk (Figure 1). The most recent 10-year average (1989-1998) commercial harvest for both districts combined is approximately 27,000 chinook, 61,000 sockeye, 334,000 chum, and 514,000 coho salmon (Burkey et al. 2000). The 1989-1998 average subsistence harvest of chinook, sockeye, chum and coho salmon in the Kuskokwim River is approximately 84,000, 39,000, 84,000, and 41,000 respectively (Burkey et al. 2000). The Kwethluk River is one of many salmon producing tributaries of the Kuskokwim River that support these fisheries.

Kwethluk River salmon stocks are harvested by commercial and subsistence fishers in District 1 and by subsistence and sport fishers in the Kwethluk River. The overall exploitation rate of Kwethluk River salmon stocks is unknown due to the lack of stock identification tools. Previous genetic studies have not been able to distinguish among stocks of early run chum salmon in the Kuskokwim River, which includes the Kwethluk River chum salmon population (Seeb et al. 1997). Genetics stock identification of other species has not been investigated.

In 1992, the USFWS operated a resistance board weir on the Kwethluk River. This project was successful in enumerating salmon escapement from 21 June through 12 September. In 1996 the Association of Village Council Presidents (AVCP), in cooperation with the Alaska Department of Fish and Game (ADF&G) and USFWS, initiated and operated a salmon counting tower (Cappiello and Sundown 1998). Funding was renewed to continue the project in 1997, 1998 and 1999. This report presents the results of the 1999 counting tower operation.

## METHODS

### *Study Site*

The counting tower and field camp were located approximately 130 river kilometers (rkm) from Bethel (60.29.049 N lat.; 161.05.296 W long.; Figure 1). The camp and one tower were located on the west bank (Figure 2), at approximately rkm 83 of the Kwethluk River. The tower was approximately 3 km upstream from the 1992 weir site. The channel width at the tower site was approximately 53 m, with a maximum depth of 1 m at normal flow. Immediately upstream from the tower site, a narrow and shallow channel branches off the mainstem and joins an old oxbow that rejoins the mainstem several hundred meters downstream from the tower site. No fish were observed attempting to migrate through this small channel.

### *Tower Operation*

A fish lead (approximately 22 m wide), measuring 28" wide by 80" high, assembled from wooden tripods and tubular aluminum panels, directed fish over an open stretch of channel with flash panels attached to the substrate for contrast. Three 500W halogen lights used for lighting were attached to the 20 ft tower fashioned from scaffolding and constructed and situated similar to that in 1996, 1997 and 1998 (Chris and Cappiello, 1999), (Figure 1). As in 1998, white-painted expanded steel with dimensions of 48" x 96" and 3/4" mesh was used for flash panels, instead of sandbags, and an additional spotlight was added. This paneling, which was the distance between the riverbank and the end of the weir, was approximately 29.3 m wide.

The project was scheduled to operate from about 22 June to 6 September with 20 minute counts being made every hour, 24 h per day, 7 days per week. Age, sex and length (ASL) sampling by beach seine was proven to be unsuccessful in 1997, due to the swiftness of the Kwethluk River and the difficulty of using beach seines in such debris-filled waters (Cappiello and Sundown 1998).

### *Data Analysis*

For each 24 h period (0000 to 2300 h) fish passage was counted the first 20 minutes of each hour. This actual count was then multiplied by three to obtain the expanded full-hour passage. At the end of the last count each day, the full-hour counts were summed to generate the daily passage estimates. If hourly counts are ever missed, they are accounted for with an interpolated "estimate." During the 1999 season no hourly counts were estimated. The first day wasn't given a daily total estimate because of the lack of adjacent days to extrapolate from.



## RESULTS

The operational period fell short of the intended dates. Counting first began at 1500 hours on 15 July, 24 days later than intended. The delay was the result of poor counting conditions. The final count for the season occurred at 2320 hours on 18 August, 19 days earlier than intended. The premature end was the result of recommendations by staff from ADF&G and BSFA for cost savings. Water conditions during the operating period were adequate for counting fish (Appendix A.1). The counting schedule was uninterrupted except on 21 July when counts were suspended from 0100 to 2300 h due to poor water clarity, and on 17 August, for two hours (0700 and 0800), due to patchy fog. Tables 1 through 5 present the actual 20 minute counts, the expanded full-hour estimates, total hours counted, and the estimated daily counts for each salmon species. Figure 3 illustrates the 1999 daily passage estimates for each species.

The total expanded count of chinook salmon was 873 (Table 1). Chinook salmon were first counted on 15 July and continued to pass through the end of the operational period. Neither the beginning nor the midpoint of the chinook run were identified due the truncated operational period.

The total expanded count of sockeye salmon was 234 (Table 2). Sockeye were first counted on 15 July and continued to pass through the end of operational period. As with chinook, neither the beginning nor the midpoint of the sockeye run were identified.

The total expanded count of chum salmon was 702 (Table 3). Chum were first counted on 15 July and continued to pass through the end of the operational period. Once again, neither the beginning nor the midpoint of the chum run were identified.

The total expanded count of pink salmon was 678 (Table 4). Pinks were first counted on 23 July and continued to pass through the end of the operational period. The pink run was expected to peak about mid-August and continue to mid-September. No conclusions on run timing or strength were made for 1999 due to the late start and early finish in counting.

The total expanded count of coho salmon was 693 (Table 5). Coho were first counted on 28 July and continued to pass through the end of the operational period. Once again, the coho run was expected to peak around late August and continue well into September. As with pinks, no conclusions on run timing or strength were made for 1999.

Tables 6 through 10 show the historic daily passage estimates, the cumulative counts and the percent passage by species, for applicable years for the 1992 and 1996 through 1999 operational periods. The cumulative counts of the truncated 1999 counting schedule, along with the same time period from the previous three years of operation, is outlined to compare those estimated passages.

## DISCUSSION

An important analytical aspect of the escapement from this tower project, and tower projects in general, is ensuring that estimated portions of the total are not biased. Since there were no estimated hourly counts in 1999, this was not of concern. In order for the estimate of the total run size to be unbiased, the 20 min counts must be representative of the entire hour's passage. Possible factors that could affect the extrapolated counts include driving a boat across the river or other activity such as making repairs to the flash panels, or noise made by the counter climbing the tower before counting.

In 1999, there were no known factors that could have systematically biased the estimates of fish passage. The tower and camp were located on the same riverbank so there was no need to frequently cross the river. Weir and flash panel cleaning and/or repairs were generally done during the morning hours from 0600 to 1200, either before or after a counting shift by one of the technicians. Counting was not interrupted, although this activity could have disrupted passage between counts.

The estimated number of chinook salmon counted in 1999 (873) was lower, during the same operating period, than in previous years. The total count of chinook between 15 July and 18 August from the Kwethluk weir project in 1992 was 3,253 (Harper 1998). The total count of chinook salmon in 1992 was 9,675 when the weir was operated from 21 June to 12 September (Harper 1998). Tower estimates in 1996 and 1997 were approximately 7,400 and 10,400, respectively (Cappiello and Sundown 1998); with only about 3% to 5% of the run yet to pass based on run timing in 1992. Chinook salmon are harvested by subsistence fishers and taken incidentally in the commercial chum fishery in the Kuskokwim River. Low chum salmon returns in 1999 once again limited Kuskokwim River fishing to one short commercial fishing period during the directed chum fishery. Consequently, the incidental commercial harvest of chinook salmon was reduced.

The estimated number of sockeye salmon counted between 15 July and 18 August 1999 (234) was somewhat lower than counted in the same period in 1992 (358) when the weir was operated. Typical sockeye rearing habitat, such as large volume lakes, is absent in the Kwethluk River drainage. There are some smaller lakes in the headwaters but their potential for sockeye production is unknown. The returns of 1,316 in 1992 (Harper 1998), 1,804 in 1996 and 1,374 in 1997 (Cappiello and Sundown 1998), characterize the Kwethluk River's habitat as one that may be limited to a total run size to be less than 2,000. Similar to the Holitna River (Figure 1), the sockeye salmon in the Kwethluk are most likely a "river-type"; that is they spawn and rear exclusively in flowing waters.

The estimated number of chum salmon passed in 1999 between 15 July and 18 August (702) was much lower, during the same period in 1992, when 18,408 chum passed the weir (Harper 1998). Low chum escapements were observed at other assessment projects throughout the Kuskokwim River drainage in 1999. As mentioned above, only one commercial fishing period was allowed in

District 1 during the chum directed fishery.

With the shortened counting schedule in 1999, the only objective comparisons to make are of that same time period counted in 1999, to those in previous years (15 July to 18 August). The only year which counted the same period of time was 1992. Along these lines, chinook salmon returns in 1999 were 26.8% (N=873) of what returned in 1992 (3,253). Sockeye salmon were 65.4% (N=234) of 1992 counts (358). Chum salmon returns were 3.8% (N=702) of 1992 counts (18,408). Pink salmon were 1.6% (N=678) of what returned in 1992 (43,486). Coho salmon returned at 9.3% (N=693) of that of 1992 (7,477), counts in the same time period. These numbers support the fact that many of the systems monitored on the Kuskokwim River saw disastrous returns in 1999, although the escapement data in 1999 was not adequate enough to declare all species' escapements to be disastrous. Also, the subsistence needs appeared to have been met, while there was very limited commercial fishing.

The Kwethluk River tower operation ended before escapements of pink and coho salmon could be assessed. In 1992, the floating weir operated until 12 September, well after peak migration of both species. The coho and pink salmon escapements in 1992 were 45,952 and 45,605 respectively (Harper 1998). Little is actually known about the run dynamics and escapement of pink salmon throughout the Kuskokwim River. Pink salmon exhibit even year dominance, and therefore, are expected to arrive in lower numbers in 1999, compared to even years. Pink salmon generally occur in relatively low numbers in the Kuskokwim River. They are not a very important commercial or subsistence resource although they may be an important source of nutrient enrichment for some systems. The count of pinks at the Kwethluk River weir in 1992 was the highest documented escapement of this species in any stream in the Kuskokwim Area.

Because the Kwethluk River tower is relatively far upstream and close to the spawning grounds, most salmon observed passing are water marked (in spawning coloration) and fairly easy to identify. However, species identification concerns are inherent in any fish counting tower project where more than one species occurs. Although species identification problems were not fully assessed, misidentification was presumed low, until water conditions became such that identification was rather difficult and somewhat questionable. After consulting with ADF&G and the Bering Sea Fishermen's Association (BSFA), it was agreed that the project would be cut short in order to save money for other projects.

The Kwethluk River characteristically, is susceptible to high water from seasonal freshets, and murky water caused by clay or loess riverbanks. The tower is on the west side of the river and glare from the morning sun has a negative impact on an observer's ability to see fish. To help alleviate this problem, polarized sunglasses were worn by the counters to help in seeing the fish. Fortunately, fish passage is generally low during the morning hours. During 1999, there were two periods (21 July, from 0100 to 2300 h, and 17 August, from 0700 to 0800 h) where water conditions impaired the ability to count fish. This was in addition to the high waters that kept the project from starting as desired. Water conditions were high throughout the Kuskokwim River drainage, during the operational period of the project.

## RECOMMENDATIONS

The Kwethluk River tower project was operated rather well during the truncated 1999 season. Several of the field technicians were returning crew and very experienced and adept at species identification. The remote nature of the tower and field camp has both negative and positive aspects. There are few suitable sites for a tower downstream so the general vicinity of the present location is appropriate. The biggest difficulties with the tower operations were the high water conditions and maintaining the morale of the crew.

Subsistence activities are a necessary part of life in the Kuskokwim area, and are not always compatible with a wage-earning work schedule. One way to address this problem with those working as technicians on this project is to rotate personnel on a one-week-on and one-week-off schedule or something of that nature. This year an alternate technician was hired to be "on call" to accommodate a "time off" schedule. Having additional people trained and familiar with such a project is beneficial. There are many variations of scheduling employees for tower projects but the main intent is to get 24-h counts *and* maintain crew morale. It is recommended however that prior to hiring or rehiring personnel, their needs are identified and all attempts should be made to accommodate them with a flexible schedule.

Sampling by beach seine for ASL information was unsuccessful in 1996 and 1997 (Cappiello and Sundown 1998), again due to the swiftness and the amount of debris found in the Kwethluk River. Therefore, such attempts were not made in 1999. Instead, as in 1998, this project concentrated on counting 24 hours each day, 7 days a week. A favorable counting schedule would be one where a technician's shift would be to count 8 hours, therefore requiring a minimum of three people needed at all times on staff. If 24-h counts are not possible everyday, an 18-h per day count schedule is acceptable, only if 24-h counts can be made regularly; a minimum of 2 or 3 times a week. It is also important to sample most intensively during the peak of the species run of interest. There are many ways to schedule employees for tower projects, but again, the main objective should be to maximize the number of counts while maintaining crew morale, and staying within the budget.

Although species identification was not known to be a significant problem at the Kwethluk River tower, differences in identification among the crew should be assessed, especially if new crewmembers are hired. Accurately validating the species of passing salmon would be difficult, but knowing relative observer error would be important for assessing overall success of the project. It would be beneficial to have "test" counts at the beginning of the operation period, and also during peak times, where two people count simultaneously, after the 20 min count is achieved by the assigned counter. Then, compare their numbers and identify any differences in counts and address what might be the causes. These calibration counts would be helpful in estimating the percentage of "error" between observers.

One difficulty that was apparent during 1997 was the inadequacy of the lighting system for counting at night. The lights used were too diffuse, and more concentrated spot-type lighting was

needed. In 1998 an additional spotlight was attached to the tower and used at night. This system was repeated again in 1999. Also needed was a better substrate cover and flash-panel system. The previous method of using white sand bags is acceptable only as a last resort. Expanded steel, which is a mesh-like fencing, was purchased, painted white, and placed on the river bottom and secured with sand bags for the 1998 and 1999 seasons. With this new paneling, there were two small problems observed and identified by the experienced technicians, which were an occasional pile-up of gravel on a panel, or rust forming on lightly coated areas. It is now the preferred system to use, when compared to using sandbags.

The difficult accessibility of the Kwethluk River tower site complicates logistics. In 1999, as well as in the previous years, many costly trips by jet boat were made to resupply the camp with food, gas and supplies. With some careful planning, supply trips should not be necessary more than once a week. At the beginning of the season enough trips should be made to haul in gas and food to last several weeks. A regular supply trip schedule should be established so that the crew knows when to expect supplies, and people who are involved with the project can plan ahead for visiting and helping out. Communications with a VHF radio to Bethel were often unreliable. Use of a single-side-band radio with the ADF&G office seemed to be the best way to communicate and will be used in following years.

The late start-up and premature end in 1999 was unavoidable due to the high and murky water conditions. We can expect this to continue to periodically inhibit the completion of our goal on the Kwethluk River. Still, for two of the four years of operation, water conditions did allow for adequate enumerating in June and most of July, when most of the chinook passage occurs. Full assessment of the chum salmon escapement, however, has not been achieved in any of the four years of tower operation. In 1999, we likely missed the majority of the chinook and chum salmon runs due to the late start-up date. In 1996 and 1997 much of the second half of the chum run was missed, due to the premature end of operation.

Realistically, there is little hope for the tower to be operated for the entire pink and coho runs, because of the chronically poor counting conditions that occur during these runs. The limited operating time inherent to counting tower operations on the Kwethluk River will continue to significantly hinder fulfillment of project objectives.

The most effective solution to these problems is to install a floating weir on the Kwethluk River. A floating weir would solve most, if not all of the problems that are associated with the high water conditions that occur each season on this river, and in trying to get full, actual escapement counts for each salmon species. The effectiveness of a weir was proven in 1992.

The tower operation should continue as long as the budget will allow, but there is little reason to continue past mid-August if the objectives do not include enumerating coho and pink salmon.

The goal of the Kwethluk River counting tower is to estimate the total spawning populations of each salmon species in the river. As such, it is critically important that the project be in operation during the entire duration of each salmon run being monitored.

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Table 1. Net upstream passage (actual and expanded) of chinook salmon during hourly 20-min counts at the Kwethluk River Tower, 1999. Negative numbers represent fish going downstream. Shaded areas indicate no counts made.

Total Hours																						Total	Expanded						
Date	Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Count	Count		
7/15	9																-1	1	3	0	1	0	-2	4	0	6	18		
7/16	24	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	1	0	0	1	1	9	27		
7/17	24	0	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	1	1	8	24		
7/18	24	0	0	1	0	0	1	0	0	0	0	0	0	-1	2	0	0	0	0	1	0	1	1	1	2	9	27		
7/19	24	2	3	11	5	4	2	0	0	0	0	0	0	0	0	0	1	2	0	4	12	11	10	0	2	69	207		
7/20	24	1	6	1	5	2	1	0	0	0	0	0	-1	1	1	0	1	-1	0	1	2	0	-1	0	0	19	57		
7/21	1	1																										1	3
7/22	24	2	1	0	3	2	0	1	0	0	0	-1	1	0	0	0	1	1	0	1	0	0	0	0	1	13	39		
7/23	24	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2	0	1	6	18		
7/24	24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	3	2	0	3	1	11	33		
7/25	24	0	0	0	0	0	0	0	3	0	0	0	1	0	-1	0	0	3	0	3	0	0	1	0	0	10	30		
7/26	24	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	-1	0	5	1	12	36		
7/27	24	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	9	3	2	2	2	20	60		
7/28	24	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	-1	0	6	2	0	5	3	1	18	54		
7/29	24	0	1	2	0	0	-1	2	0	0	0	0	0	4	2	3	-1	0	2	5	0	0	0	0	1	20	60		
7/30	24	0	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	9		
7/31	24	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	2	0	1	0	3	0	0	11	33		
8/1	24	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	6	18		
8/2	24	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	3	0	0	2	3	2	1	1	0	17	51		
8/3	24	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	6	18		
8/4	24	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	3	0	0	0	6	18		
8/5	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3		
8/6	24	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3		
8/7	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	6		
8/8	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
8/9	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3		
8/10	24	0	1	0	0	0	0	0	0	0	-3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-3		
8/11	24	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	6		
8/12	24	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6		
8/13	24	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0		
8/14	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	3		
8/15	24	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0		
8/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
8/17	22	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	3		
8/18	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	3		

Table 2. Net upstream passage (actual and expanded) of sockeye salmon during hourly 20-min counts at the Kwethluk River Tower, 1999.  
Negative numbers represent fish going downstream. Shaded areas indicate no counts made.

Date	Total Hours Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total Count	Expanded Count
7/15	9																0	0	2	0	0	2	0	0	0	4	12
7/16	24	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	3	0	2	1	1	2	0	11	33
7/17	24	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	-1	1	0	2	0	6	18
7/18	24	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	3	1	2	1	0	0	12	36
7/19	24	0	0	2	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	2	1	12	36
7/20	24	0	1	1	0	1	0	0	0	0	0	0	0	0	0	-1	0	-1	0	0	1	2	1	0	0	5	15
7/21	1	0																								0	0
7/22	24	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	12
7/23	24	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3	9
7/24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	9
7/25	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
7/26	24	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	6
7/27	24	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	9
7/28	24	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	2	6
7/29	24	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	9
7/30	24	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	6
7/31	24	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6
8/1	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	6
8/2	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/3	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/4	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/5	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/6	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/7	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/8	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/9	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/10	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/11	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3
8/12	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/14	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/15	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/17	22	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/18	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Table 3. Net upstream passage (actual and expanded) of chum salmon during hourly 10-min counts at the Kwethluk River Tower, 1999.

Negative numbers represent fish going downstream. Shaded areas indicate no counts made.

Total Hours																									Total	Expanded	
Date	Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Count	Count
7/15	9																0	0	1	1	0	2	0	6	0	10	30
7/16	24	1	5	4	1	1	2	-1	0	2	0	0	0	0	0	0	0	0	-1	0	0	0	0	1	0	15	45
7/17	24	0	4	1	2	0	0	0	0	0	0	0	0	0	0	1	0	0	-1	0	0	1	0	-1	0	7	21
7/18	24	0	1	3	2	0	4	1	0	0	2	1	0	0	2	1	0	0	2	2	0	0	2	-1	0	22	66
7/19	24	6	5	2	3	2	1	1	-1	0	0	0	0	0	0	0	0	0	3	0	1	0	1	0	1	25	75
7/20	24	1	2	2	2	3	3	0	1	0	-1	0	0	2	0	0	2	0	0	0	0	6	0	3	2	28	84
7/21	1	2																						2	6		
7/22	24	3	2	0	4	5	0	0	4	0	0	0	0	0	0	0	1	0	0	0	0	1	1	-1	2	22	66
7/23	24	0	0	0	4	0	0	1	0	1	1	0	0	0	0	0	0	1	-1	0	3	4	0	3	2	19	57
7/24	24	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	2	0	0	0	6	18
7/25	24	-1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	5	15
7/26	24	0	0	0	0	0	0	1	0	-1	0	-1	1	0	0	1	0	0	0	0	0	2	0	0	1	4	12
7/27	24	0	0	4	-1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	9	27
7/28	24	0	0	0	1	1	-1	0	0	1	0	0	0	0	-1	0	0	0	0	0	0	0	-1	0	0	0	0
7/29	24	0	0	0	2	0	0	0	0	0	2	-2	0	1	0	0	1	1	0	0	1	3	0	2	0	11	33
7/30	24	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	0	9	1	19	57
7/31	24	0	1	1	0	0	1	1	0	0	0	0	0	0	0	3	0	0	0	2	-1	2	1	0	0	11	33
8/1	24	1	-1	0	0	0	0	-1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	6
8/2	24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
8/3	24	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	-6
8/4	24	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
8/5	24	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6
8/6	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	-3
8/7	24	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6
8/8	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	8	24
8/9	24	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-1	0	0	0	0	0	2	6
8/10	24	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-3
8/11	24	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
8/12	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	9
8/13	24	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
8/14	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	-1	-1	0	2	0	0	0	0	0	0	1	3
8/15	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	3
8/17	22	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/18	24	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-3

Table 4. Net upstream passage (actual and expanded) of pink salmon during hourly 20-min counts at the Kwethluk River Tower, 1999.

Negative numbers represent fish going downstream. Shaded areas indicate no counts made.

Date	Total Hours Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total Count	Expanded Count
7/15	9																0	0	0	0	0	0	0	0	0	0	0
7/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/17	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/18	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/19	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/20	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/21	1	0																								0	0
7/22	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/23	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3
7/24	24	0	4	0	0	0	0	0	-1	0	0	0	0	0	0	2	0	0	1	0	0	0	0	1	0	7	21
7/25	24	3	2	3	2	-2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	11	33
7/26	24	1	0	3	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6	18
7/27	24	1	0	2	2	0	0	1	1	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	10	30
7/28	24	1	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	18
7/29	24	1	1	1	0	1	0	1	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	1	0	10	30
7/30	24	2	1	0	2	1	0	1	2	0	0	0	0	0	1	0	1	0	0	0	3	0	1	1	1	17	51
7/31	24	1	1	0	0	0	2	0	0	0	0	0	1	0	0	2	0	0	0	0	0	1	0	2	1	11	33
8/1	24	1	0	1	2	1	0	0	0	-1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	6	18
8/2	24	-1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	4	12
8/3	24	0	5	0	4	3	1	-1	0	0	0	0	0	0	0	0	0	2	0	3	0	0	0	0	0	17	51
8/4	24	0	2	2	0	0	-1	0	1	0	0	0	0	0	0	-1	0	0	0	0	1	0	0	1	2	7	21
8/5	24	2	1	2	0	0	0	2	0	1	2	2	0	0	0	3	0	0	0	0	0	-1	0	1	0	15	45
8/6	24	0	-1	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	-1	0	0	0	0	0	3	9
8/7	24	1	1	0	0	0	1	0	1	0	0	1	0	-1	0	0	-1	0	0	0	0	0	1	0	0	4	12
8/8	24	0	1	0	0	2	0	0	0	1	1	0	0	0	0	0	0	0	0	3	0	1	0	1	0	10	30
8/9	24	1	0	0	0	0	0	0	1	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	7	21
8/10	24	0	1	2	1	0	3	2	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	14	42
8/11	24	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5	15
8/12	24	2	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	1	10	30
8/13	24	3	2	0	2	1	0	0	2	1	0	2	1	0	0	1	-1	1	1	1	0	0	0	1	2	20	60
8/14	24	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0	2	0	1	9	27
8/15	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	0	0	0	0	5	15
8/16	24	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0	1	0	0	1	0	0	1	1	0	8	24
8/17	22	0	2	0	0	0	0	1	0			0	0	0	0	-1	0	0	0	0	0	0	0	0	0	2	6
8/18	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3

Table 5. Net upstream passage (actual and expanded) of coho salmon during hourly 15-min counts at the Kwethluk River Tower, 1999.  
Negative numbers represent fish going downstream. Shaded areas indicate no counts made.

Date	Total Hours																								Total Count	Expanded Count																	
	Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200			2300																
7/15	9																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
7/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/17	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/18	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/19	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/20	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/21	1	0																																									
7/22	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/23	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/25	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/26	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/27	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
7/28	24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3																
7/29	24	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	6	18																
7/30	24	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6																
7/31	24	1	1	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	1	0	7	21																
8/1	24	1	2	1	0	0	0	0	0	0	2	0	2	0	0	0	0	1	0	0	0	0	0	0	0	9	27																
8/2	24	0	0	0	0	1	0	0	1	0	1	0	0	0	0	3	0	0	0	0	0	2	2	2	0	12	36																
8/3	24	0	0	0	0	0	0	2	0	2	0	0	0	0	0	2	0	2	1	0	0	0	1	0	10	30																	
8/4	24	1	2	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	7	21																
8/5	24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	4	12																
8/6	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	6																
8/7	24	0	0	0	0	0	2	1	0	1	0	0	0	1	0	0	1	0	0	0	3	0	2	2	0	13	39																
8/8	24	0	0	1	1	0	1	0	0	0	0	1	0	1	0	0	0	1	-1	0	0	2	0	0	0	7	21																
8/9	24	1	4	0	1	5	0	0	3	1	0	0	0	0	1	0	-1	0	2	0	0	0	0	0	1	18	54																
8/10	24	2	0	3	0	0	1	2	2	2	0	0	2	0	0	0	2	1	4	0	1	1	0	0	0	23	69																
8/11	24	2	0	0	3	0	1	0	0	-1	0	3	1	2	1	0	0	1	0	0	1	0	5	0	1	20	60																
8/12	24	1	2	1	3	2	0	0	1	0	0	0	0	0	1	1	1	8	0	1	0	0	3	2	1	28	84																
8/13	24	0	1	1	4	0	0	1	0	0	0	0	1	0	0	0	0	2	0	0	2	0	0	0	4	16	48																
8/14	24	0	2	2	0	2	0	0	0	0	0	0	0	0	1	0	1	2	1	2	0	2	0	0	0	15	45																
8/15	24	0	0	1	0	2	0	0	0	1	0	0	0	1	0	1	0	2	1	1	0	0	0	1	0	11	33																
8/16	24	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	5	15																
8/17	22	0	0	0	1	1	0	0	1			0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	9																
8/18	24	0	0	2	0	0	0	0	0	0	0	1	0	1	2	1	0	3	0	0	2	0	0	0	0	12	36																

Table 6. Historic chinook salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1999).

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
6/20													
6/21	0					0					0		
6/22	2	15	0			2	15	0			0	0	0
6/23	3	96	51			5	111	51			0	1	1
6/24	2	51	288			7	162	339			0	2	4
6/25	36	42	138			43	204	477			0	3	5
6/26	42	3	153			85	207	630			1	3	7
6/27	64	75	216			149	282	846			2	4	9
6/28	55	214	324			204	496	1,170			2	6	13
6/29	89	253	315			293	749	1,485			3	10	16
6/30	108	211	261			401	960	1,746			4	12	19
7/01	202	49	63			603	1,009	1,809			6	13	20
7/02	358	107	444			961	1,116	2,253			10	14	24
7/03	497	111	775			1,458	1,227	3,028			15	16	33
7/04	1,248	1,098	822			2,706	2,325	3,850			28	30	42
7/05	400	746	1,144			3,106	3,071	4,994			32	39	54
7/06	642	563	1,050			3,748	3,634	6,044			39	46	66
7/07	364	336	145			4,112	3,970	6,189			43	51	67
7/08	442	393	94			4,554	4,363	6,283			47	56	68
7/09	361	519	16			4,915	4,882	6,299			51	62	68
7/10	661	339	3			5,576	5,221	6,302			58	66	
7/11	381	210	91			5,957	5,431	6,393			62	69	
7/12	304	155	124			6,261	5,586	6,517			65	71	71
7/13	36	186	216			6,297	5,772	6,733			65	73	73
7/14	137	210	192			6,434	5,982	6,925			67	76	75
7/15	548	115	174		18	548	115	174		18	72	78	77
7/16	366	387	330		27	914	502	504		45	76	83	81
7/17	317	252	337		24	1,231	754	841		69	79	86	84
7/18	273	155	372		27	1,504	909	1,213		96	82	88	88
7/19	69	242	630		207	1,573	1,151	1,843		303	83	91	95
7/20	46	135	111		57	1,619	1,286	1,954		360	83	92	96
7/21	205	217	117		3	1,824	1,503	2,071		363	85	95	97
7/22	144	179	231		39	1,968	1,682	2,302		402	87	98	100
7/23	195	83			18	2,163	1,765			420	89	99	
7/24	149	55		9	33	2,312	1,820		9	453	90	99	
7/25	122	45		21	30	2,434	1,865		30	483	92	100	
7/26	143	3		0	36	2,577	1,868		30	519	93	100	
7/27	35	9		21	60	2,612	1,877		51	579	94	100	
7/28	39			9	54	2,651			60	633	94		
7/29	49			0	60	2,700			60	693	94		
7/30	49			0	9	2,749			60	702	95		
7/31	89			12	33	2,838			72	735	96		

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Table 6. (page 2 of 2)

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
8/01	44			15	18	2,882			87	753	96		
8/02	33			3	51	2,915			90	804	97		
8/03	11			6	18	2,926			96	822	97		
8/04	18			3	18	2,944			99	840	97		
8/05	23			0	3	2,967			99	843	97		
8/06	65			3	3	3,032			102	846	98		
8/07	19			0	6	3,051			102	852	98		
8/08	26			12	0	3,077			114	852	98		
8/09	16			0	3	3,093			114	855	98		
8/10	7			0	-3	3,100			114	852	99		
8/11	11			0	6	3,111			114	858	99		
8/12	27			0	6	3,138			114	864	99		
8/13	72			3	0	3,210			117	864	99		
8/14	18			0	3	3,228			117	867	100		
8/15	8			3	0	3,236			120	867	100		
8/16	4			0	0	3,240			120	867	100		
8/17	6			0	3	3,246			120	870	100		
8/18	7			0	3	3,253			120	873	100		
8/19	3					3,256					100		
8/20	3					3,259					100		
8/21	3					3,262					100		
8/22	0					3,262					100		
8/23	0					3,262					100		
8/24	3					3,265					100		
8/25	0					3,265					100		
8/26	0					3,265					100		
8/27	0					3,265					100		
8/28	0					3,265					100		
8/29	1					3,266					100		
8/30	0					3,266					100		
8/31	0					3,266							
9/01	0					3,266							
9/02	0					3,266							
9/03	0					3,266							
9/04	1					3,267							
9/05	0					3,267							
9/06	0					3,267							
9/07	0					3,267							
9/08	0					3,267							
9/09	0					3,267							
9/10	1					3,268							
9/11	0					3,268							
9/12	0					3,268							

Table 7. Historic sockeye salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1999).

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
6/20	0												
6/21	0					0					0		
6/22	6	0	0			6	0	0			0	0	0
6/23	34	0	0			40	0	0			0	1	1
6/24	53	0	0			93	0	0			0	2	4
6/25	70	0	21			163	0	21			0	3	5
6/26	41	6	39			204	6	60			1	3	7
6/27	69	69	21			273	75	81			2	4	9
6/28	51	105	102			324	180	183			2	6	13
6/29	34	63	93			358	243	276			3	10	16
6/30	14	75	90			372	318	366			4	12	19
7/01	30	54	24			402	372	390			6	13	20
7/02	63	111	42			465	483	432			10	14	24
7/03	75	135	69			540	618	501			15	16	33
7/04	86	89	228			626	707	729			28	30	42
7/05	38	67	135			664	774	864			32	39	54
7/06	58	86	87			722	860	951			39	46	66
7/07	50	168	32			772	1,028	983			43	51	67
7/08	45	186	55			817	1,214	1,038			47	56	68
7/09	36	110	10			853	1,324	1,048			51	62	68
7/10	36	34	6			889	1,358	1,054			58	66	68
7/11	13	92	0			902	1,450	1,054			62	69	
7/12	16	73	60			918	1,523	1,114			65	71	71
7/13	5	115	24			923	1,638	1,138			65	73	73
7/14	23	48	27			946	1,686	1,165			67	76	75
7/15	33	53	24		12	33	53	24		12	72	78	77
7/16	18	42	24		33	51	95	48		45	76	83	81
7/17	19	66	17		18	70	161	65		63	79	86	84
7/18	20	24	23		36	90	185	88		99	82	88	88
7/19	19	30	45		36	109	215	133		135	83	91	95
7/20	21	57	0		15	130	272	133		150	83	92	96
7/21	19	42	12		0	149	314	145		150	85	95	97
7/22	8	9	27		12	157	323	172		162	87	98	100
7/23	17	6			9	174	329			171	89	99	
7/24	4	0		3	9	178	329		3	180	90	99	
7/25	5	39		12	3	183	368		15	183	92	100	
7/26	14	0		6	6	197	368		21	189	93	100	
7/27	8	3		0	9	205	371		21	198	94	100	
7/28	10			12	6	215			33	204	94		
7/29	8			21	9	223			54	213	94		
7/30	9			18	6	232			72	219	95		
7/31	15			21	6	247			93	225	96		

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Table 7. (page 2 of 2)

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
8/01	12			24	6	259			117	231	96		
8/02	9			0	0	268			117	231	97		
8/03	8			0	0	276			117	231	97		
8/04	4			0	0	280			117	231	97		
8/05	6			0	0	286			117	231	97		
8/06	18			0	0	304			117	231	98		
8/07	8			0	0	312			117	231	98		
8/08	8			0	0	320			117	231	98		
8/09	7			0	0	327			117	231	98		
8/10	6			0	0	333			117	231	99		
8/11	5			3	3	338			120	234	99		
8/12	5			0	0	343			120	234	99		
8/13	5			0	0	348			120	234	99		
8/14	3			0	0	351			120	234	100		
8/15	2			0	0	353			120	234	100		
8/16	3			0	0	356			120	234	100		
8/17	2			0	0	358			120	234	100		
8/18	0			0	0	358			120	234	100		
8/19	4					362					100		
8/20	1					363					100		
8/21	1					364					100		
8/22	1					365					100		
8/23	3					368					100		
8/24	2					370					100		
8/25	1					371					100		
8/26	0					371					100		
8/27	0					371					100		
8/28	1					372					100		
8/29	0					372					100		
8/30	1					373					100		
8/31	0					373							
9/01	0					373							
9/02	0					373							
9/03	1					374							
9/04	0					374							
9/05	0					374							
9/06	0					374							
9/07	0					374							
9/08	0					374							
9/09	0					374							
9/10	0					374							
9/11	1					375							
9/12	0					375							

Table 8. Historic chum salmon passage at the Kweihluk River weir (1992) and tower (1996 - 1999).

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
6/20	0					0							
6/21	28					28					0		
6/22	82	3	0			110	3	0			0	0	0
6/23	78	132	41			188	135	41			0	1	1
6/24	83	144	30			271	279	71			0	2	4
6/25	281	102	18			552	381	89			0	3	5
6/26	449	27	54			1,001	408	143			1	3	7
6/27	346	516	27			1,347	924	170			2	4	9
6/28	314	305	84			1,661	1,229	254			2	6	13
6/29	287	811	87			1,948	2,040	341			3	10	16
6/30	30	1,307	135			1,978	3,347	476			4	12	19
7/01	147	378	72			2,125	3,725	548			6	13	20
7/02	490	706	207			2,615	4,431	755			10	14	24
7/03	908	1,179	468			3,523	5,610	1,223			15	16	33
7/04	855	2,834	579			4,378	8,444	1,802			28	30	42
7/05	469	1,357	492			4,847	9,801	2,294			32	39	54
7/06	754	1,724	372			5,601	11,525	2,666			39	46	66
7/07	533	1,916	217			6,134	13,441	2,883			43	51	67
7/08	847	1,421	124			6,981	14,862	3,007			47	56	68
7/09	522	998	32			7,503	15,860	3,039			51	62	68
7/10	1,361	803	63			8,864	16,663	3,102			58	66	68
7/11	1,169	565	99			10,033	17,228	3,201			62	69	68
7/12	831	608	266			10,864	17,836	3,467			65	71	71
7/13	716	537	96			11,580	18,373	3,563			65	73	73
7/14	589	812	60			12,169	19,185	3,623			67	76	75
7/15	1,031	448	225		30	1,031	448	225		30	72	78	77
7/16	1,145	1,503	402		45	2,176	1,951	627		75	76	83	81
7/17	751	509	296		21	2,927	2,460	923		96	79	86	84
7/18	758	346	525		66	3,685	2,806	1,448		162	82	88	88
7/19	687	495	915		75	4,372	3,301	2,363		237	83	91	95
7/20	470	861	279		84	4,842	4,162	2,642		321	83	92	96
7/21	584	1,271	348		6	5,426	5,433	2,990		327	85	95	97
7/22	731	1,071	402		66	6,157	6,504	3,392		393	87	98	100
7/23	1,102	414			57	7,259	6,918			450	89	99	
7/24	1,196	539		60	18	8,455	7,457		60	468	90	99	
7/25	894	281		162	15	9,349	7,738		222	483	92	100	
7/26	849	273		54	12	10,198	8,011		276	495	93	100	
7/27	583	266		54	27	10,781	8,277		330	522	94	100	
7/28	559			63	0	11,340			393	522	94		
7/29	841			69	33	12,181			462	555	94		
7/30	733			63	57	12,914			525	612	95		
7/31	693			45	33	13,607			570	645	96		

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Table 8. (page 2 of 2)

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
8/01	611			54	6	14,218			624	651	96		
8/02	484			12	3	14,702			636	654	97		
8/03	363			6	-6	15,065			642	648	97		
8/04	349			6	3	15,414			648	651	97		
8/05	452			21	6	15,866			669	657	97		
8/06	614			3	-3	16,480			672	654	98		
8/07	301			15	6	16,781			687	660	98		
8/08	190			6	24	16,971			693	684	98		
8/09	368			6	6	17,339			699	690	98		
8/10	231			0	-3	17,570			699	687	99		
8/11	123			12	3	17,693			711	690	99		
8/12	171			0	9	17,864			711	699	99		
8/13	238			6	0	18,102			717	699	99		
8/14	90			0	3	18,192			717	702	100		
8/15	80			0	0	18,272			717	702	100		
8/16	59			0	3	18,331			717	705	100		
8/17	37			3	0	18,368			720	705	100		
8/18	40			0	-3	18,408			720	702	100		
8/19	41					18,449					100		
8/20	30					18,479					100		
8/21	26					18,505					100		
8/22	21					18,526					100		
8/23	9					18,535					100		
8/24	17					18,552					100		
8/25	8					18,560					100		
8/26	6					18,566					100		
8/27	5					18,571					100		
8/28	7					18,578					100		
8/29	4					18,582					100		
8/30	4					18,586					100		
8/31	2					18,588							
9/01	2					18,590							
9/02	0					18,590							
9/03	2					18,592							
9/04	2					18,594							
9/05	0					18,594							
9/06	0					18,594							
9/07	2					18,596							
9/08	0					18,596							
9/09	1					18,597							
9/10	0					18,597							
9/11	0					18,597							
9/12	1					18,598							

Table 9. Historic pink salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1999).

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
6/20	0												
6/21	0					0					0		
6/22	0	0	0			0	0	0			0	0	0
6/23	0	0	0			0	0	0			0	1	1
6/24	0	0	0			0	0	0			0	2	4
6/25	1	0	0			1	0	0			0	3	5
6/26	0	0	0			1	0	0			1	3	7
6/27	1	0	0			2	0	0			2	4	9
6/28	1	0	0			3	0	0			2	6	13
6/29	1	0	0			4	0	0			3	10	16
6/30	4	0	0			8	0	0			4	12	19
7/01	7	0	0			15	0	0			6	13	20
7/02	10	0	0			25	0	0			10	14	24
7/03	33	3	0			58	3	0			15	16	33
7/04	72	42	0			130	45	0			28	30	42
7/05	7	24	0			137	69	0			32	39	54
7/06	20	42	0			157	111	0			39	46	66
7/07	21	72	0			178	183	0			43	51	67
7/08	31	81	0			209	264	0			47	56	68
7/09	25	63	9			234	327	9			51	62	68
7/10	37	33	75			271	360	84			58	66	68
7/11	35	18	0			306	378	84			62	69	
7/12	50	21	19			356	399	103			65	71	71
7/13	20	23	0			376	422	103			65	73	73
7/14	41	168	18			417	590	121			67	76	75
7/15	88	150	24		0	88	150	24		0	72	78	77
7/16	143	204	21		0	231	354	45		0	76	83	81
7/17	109	99	6		0	340	453	51		0	79	86	84
7/18	114	73	42		0	454	526	93		0	82	88	88
7/19	130	165	90		0	584	691	183		0	83	91	95
7/20	123	165	21		0	707	856	204		0	83	92	96
7/21	187	382	33		0	894	1,238	237		0	85	95	97
7/22	207	270	27		0	1,101	1,508	264		0	87	98	100
7/23	295	175			3	1,396	1,683			3	89	99	
7/24	269	169		36	21	1,665	1,852		36	24	90	99	
7/25	360	219		45	33	2,025	2,071		81	57	92	100	
7/26	423	174		96	18	2,448	2,245		177	75	93	100	
7/27	282	64		84	30	2,730	2,309		261	105	94	100	
7/28	230			129	18	2,960			390	123	94		
7/29	366			117	30	3,326			507	153	94		
7/30	331			108	51	3,657			615	204	95		
7/31	534			78	33	4,191			693	237	96		

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Table 9. (page 2 of 2)

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
8/01	558			168	18	4,749			861	255	96		
8/02	657			171	12	5,406			1,032	267	97		
8/03	399			120	51	5,805			1,152	318	97		
8/04	721			102	21	6,526			1,254	339	97		
8/05	1,261			147	45	7,787			1,401	384	97		
8/06	2,597			114	9	10,384			1,515	393	98		
8/07	1,372			141	12	11,756			1,656	405	98		
8/08	1,817			276	30	13,573			1,932	435	98		
8/09	4,271			219	21	17,844			2,151	456	98		
8/10	2,437			279	42	20,281			2,430	498	99		
8/11	2,020			342	15	22,301			2,772	513	99		
8/12	3,507			309	30	25,808			3,081	543	99		
8/13	6,601			276	60	32,409			3,357	603	99		
8/14	2,970			303	27	35,379			3,660	630	100		
8/15	2,356			219	15	37,735			3,879	645	100		
8/16	2,496			165	24	40,231			4,044	669	100		
8/17	1,422			285	6	41,653			4,329	675	100		
8/18	1,833			69	3	43,486			4,398	678	100		
8/19	1,257					44,743					100		
8/20	1,156					45,899					100		
8/21	838					46,737					100		
8/22	633					47,370					100		
8/23	417					47,787					100		
8/24	309					48,096					100		
8/25	394					48,490					100		
8/26	175					48,665					100		
8/27	111					48,776					100		
8/28	40					48,816					100		
8/29	41					48,857					100		
8/30	33					48,890					100		
8/31	31					48,921							
9/01	19					48,940							
9/02	17					48,957							
9/03	17					48,974							
9/04	12					48,986							
9/05	14					49,000							
9/06	12					49,012							
9/07	17					49,029							
9/08	7					49,036							
9/09	3					49,039							
9/10	1					49,040							
9/11	1					49,041							
9/12	1					49,042							

Table 10. Historic coho salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1999).

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
6/20	0												
6/21	0					0					0		
6/22	0	0	0			0	0	0			0	0	0
6/23	0	0	0			0	0	0			0	1	1
6/24	0	0	0			0	0	0			0	2	4
6/25	0	0	0			0	0	0			0	3	5
6/26	0	0	0			0	0	0			1	3	7
6/27	0	0	0			0	0	0			2	4	9
6/28	0	0	0			0	0	0			2	6	13
6/29	0	0	0			0	0	0			3	10	16
6/30	0	0	0			0	0	0			4	12	19
7/01	0	0	0			0	0	0			6	13	20
7/02	0	0	0			0	0	0			10	14	24
7/03	0	0	0			0	0	0			15	16	33
7/04	0	0	0			0	0	0			28	30	42
7/05	0	0	0			0	0	0			32	39	54
7/06	0	0	0			0	0	0			39	46	66
7/07	0	0	0			0	0	0			43	51	67
7/08	0	0	0			0	0	0			47	56	68
7/09	0	0	0			0	0	0			51	62	68
7/10	0	0	0			0	0	0			58	66	68
7/11	0	0	0			0	0	0			62	69	71
7/12	0	0	0			0	0	0			65	71	71
7/13	0	0	0			0	0	0			65	73	73
7/14	0	0	0			0	0	0			67	76	75
7/15	0	0	0		0	0	0	0		0	72	78	77
7/16	0	0	0		0	0	0	0		0	76	83	81
7/17	0	0	0		0	0	0	0		0	79	86	84
7/18	0	0	0		0	0	0	0		0	82	88	88
7/19	1	0	0		0	1	0	0		0	83	91	95
7/20	1	0	0		0	2	0	0		0	83	92	96
7/21	7	15	0		0	9	15	0		0	85	95	97
7/22	1	9	0		0	10	24	0		0	87	98	100
7/23	5	6			0	15	30			0	89	99	
7/24	5	27		0	0	20	57		0	0	90	99	
7/25	8	24		0	0	28	81		0	0	92	100	
7/26	12	69		0	0	40	150		0	0	93	100	
7/27	6	30		9	0	46	180		9	0	94	100	
7/28	8			21	3	54			30	3	94		
7/29	13			36	18	67			66	21	94		
7/30	38			3	6	105			69	27	95		
7/31	67			60	21	172			129	48	96		

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Table 10. (page 2 of 2)

Date	Daily					Cumulative					Percent Passage		
	1992	1996	1997	1998	1999	1992	1996	1997	1998	1999	1992	1996	1997
8/01	57			54	27	229			183	75	96		
8/02	62			24	36	291			207	111	97		
8/03	27			33	30	318			240	141	97		
8/04	40			39	21	358			279	162	97		
8/05	116			63	12	474			342	174	97		
8/06	489			90	6	963			432	180	98		
8/07	159			99	39	1,122			531	219	98		
8/08	106			141	21	1,228			672	240	98		
8/09	355			147	54	1,583			819	294	98		
8/10	133			138	69	1,716			957	363	99		
8/11	237			135	60	1,953			1,092	423	99		
8/12	605			96	84	2,558			1,188	507	99		
8/13	1,255			120	48	3,813			1,308	555	99		
8/14	793			186	45	4,606			1,494	600	100		
8/15	609			237	33	5,215			1,731	633	100		
8/16	894			357	15	6,109			2,088	648	100		
8/17	616			252	9	6,725			2,340	657	100		
8/18	752			27	36	7,477			2,367	693	100		
8/19	612					8,089					100		
8/20	701					8,790					100		
8/21	822					9,612					100		
8/22	1,651					11,263					100		
8/23	1,748					13,011					100		
8/24	2,125					15,136					100		
8/25	6,099					21,235					100		
8/26	3,677					24,912					100		
8/27	1,984					26,896					100		
8/28	1,181					28,077					100		
8/29	1,820					29,897					100		
8/30	2,003					31,900					100		
8/31	2,353					34,253							
9/01	3,425					37,678							
9/02	1443					39,121							
9/03	881					40,002							
9/04	1102					41,104							
9/05	2654					43,758							
9/06	781					44,539							
9/07	331					44,870							
9/08	357					45,227							
9/09	282					45,509							
9/10	128					45,637							
9/11	160					45,797							
9/12	413					46,210							

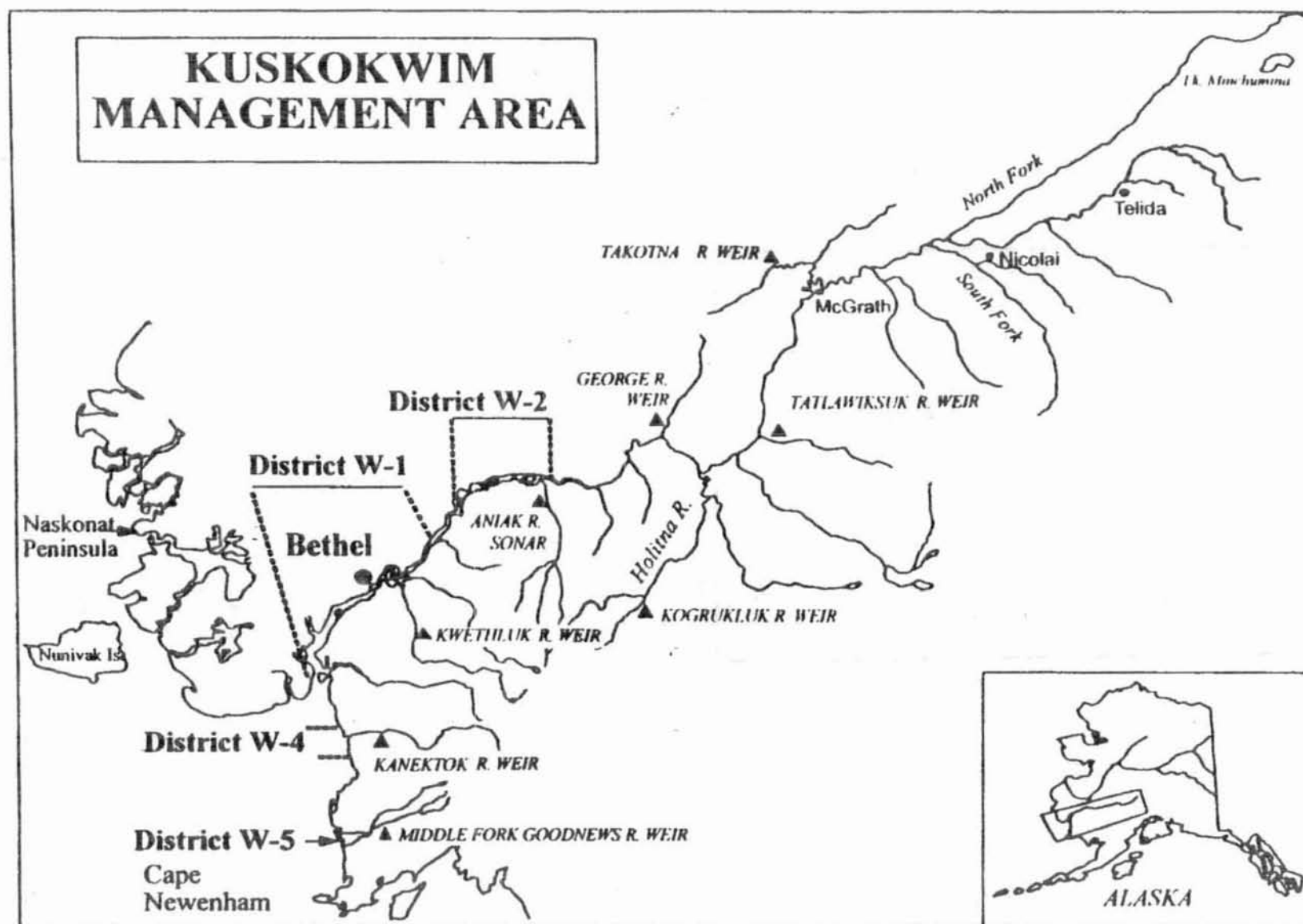


Figure 1. Kuskokwim Area map showing salmon management districts and escapement monitoring projects.

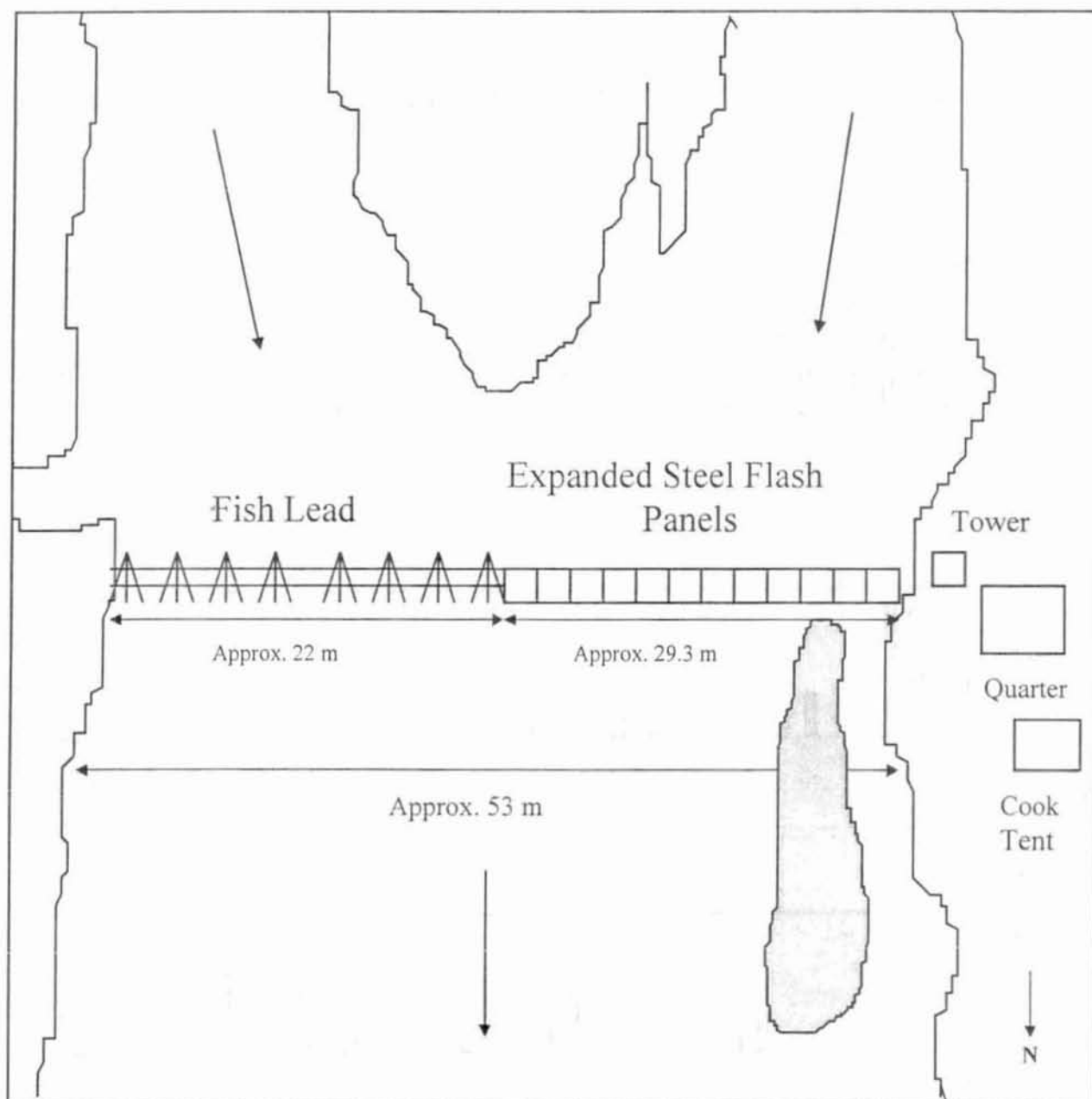


Figure 2. Schematic of the Kwethluk River counting tower and field camp (not drawn to scale; shaded area indicates a gravel bar; arrows flowing North indicate direction of water flow).

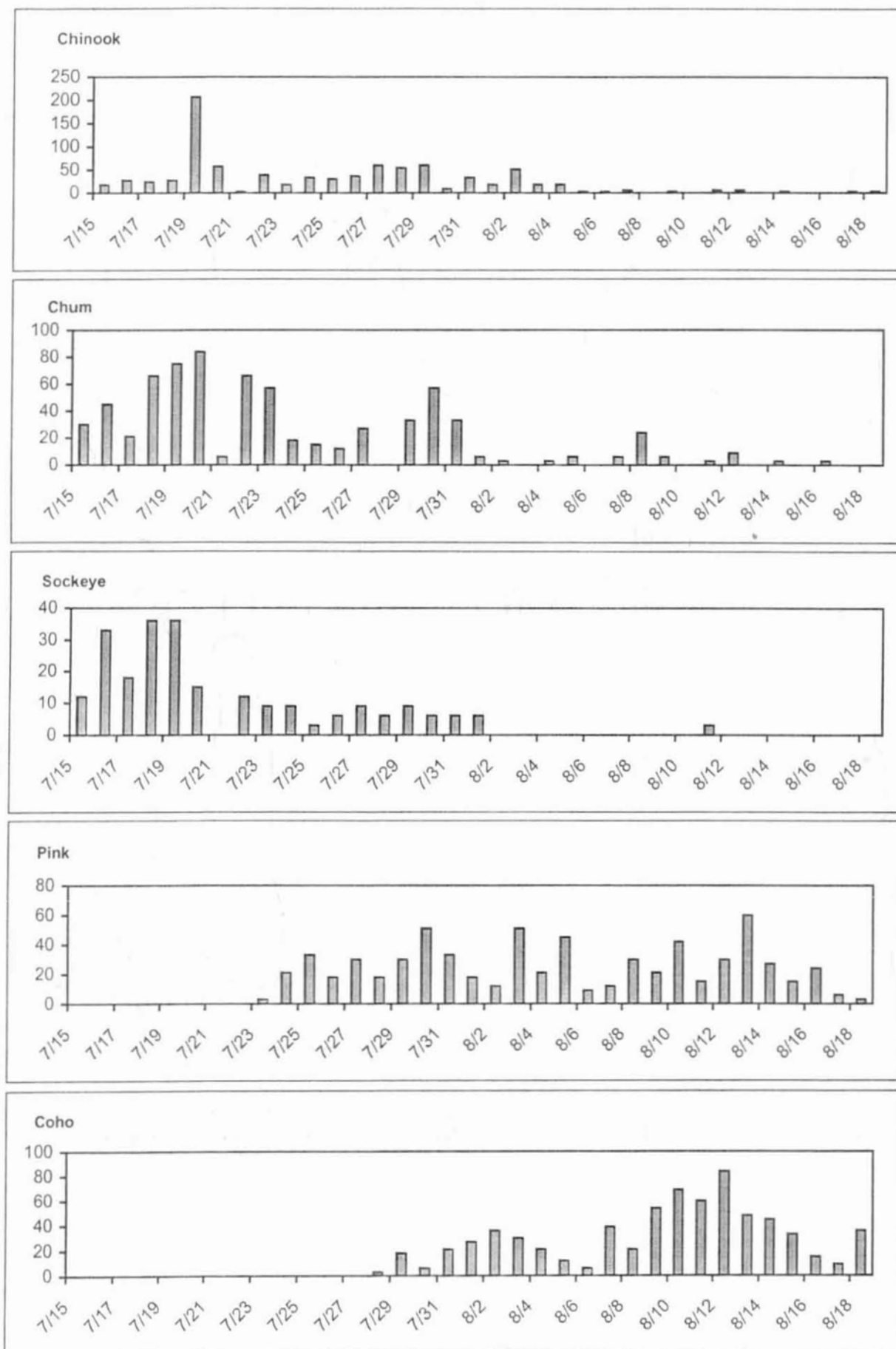


Figure 3. Daily passage estimates of salmon at the Kwethluk River counting tower, 1999.



Appendix A.1. Daily meteorological and hydrological conditions at the Kwethluk River counting tower, 1999.

Date	Time	Precipitation	Wind		Cloud Cover	Temperature (C)		Water Level (cm)	Water Clarity
			Direction	Speed (mph)		Air	Water		
18-Jun	1000	0	SE	1-3	3			48+	very murky
18-Jun	1000	2	Variable	1-3	3			48+	very murky
19-Jun	1000	0	Variable	3-5	2			48+	very murky
20-Jun	1000	2	Variable	3-5	3			48+	very murky
21-Jun	0700	0		Calm	2	6	9	48+	very murky
22-Jun	1100	0		Calm	2	10	10	48	very murky
23-Jun	0700	0	Variable	1-3	4	10	10	46	murky
24-Jun	0700	0		Calm	3	10	9	44	murky
25-Jun	0700	0		Calm	4	10	9	40	murky
26-Jun	1000	0		Calm	4	11	10	37	murky
27-Jun	1000	0	East	5-10	3	14	10	36	murky
28-Jun	0700	0		Calm	4	10	10	34	murky
29-Jun	0715	0		Calm	4	12	10	32	murky
30-Jun	0700	0		Calm	4	12	11	36	murky
01-Jul	1100	0	SE	0-5	4	10	10	34.5	murky
02-Jul	0700	1	SE	0-5	4	9	10	33	murky
03-Jul	1000	0	N	1-3	4	9	9	31.5	getting clear
04-Jul	1200	0	N	1-3	4	11	10	29.5	getting clear
05-Jul	1200	0	Variable	0-3	4	12	11	29	getting clear
06-Jul	0700	0	East	0-3	4	10	10	27.5	clear
07-Jul	0700	1		Calm	4	10	10	26	clear
08-Jul	0700	0	N	5-7	3	10	10	25.5	clear
09-Jul	1000	0	East	5-7	2	15	13	26	clear
10-Jul	1000	0		Calm	3	16	14	28.5	clear
11-Jul	1000	0	East	8-10	1	16	13	27.5	clear
12-Jul	1000	0		Calm	3	16	14	26	clear
13-Jul	1100	1	East	1-3	4	14	12	23.5	clear
14-Jul	0700	0	East	1-3	4	12	12	23	clear
15-Jul	0700	0	SE	1-3	3	9	10	22.5	clear
16-Jul	0700	0		Calm	4	10	10	21	clear
17-Jul	1000	0	SE	1-3	4	11	10	19.5	clear
18-Jul	1000	0	SE	3-5	4	12	11	17.5	clear
19-Jul	0700	1	SSW	5-10	4	10	12	18.5	clear
20-Jul	0700	0	SW	5-10	3	8	10	21	clear
21-Jul	0700	0	S	5-10	3	6	8	24	murky
22-Jul	0700	0	S	1-3	4	8	9	22	getting clear
23-Jul	0700	1	S	3-5	4	10	10	18.5	clear
24-Jul	1000	0	NNE	7-10	3	16	11	17	clear
25-Jul	1000	0	S	10-15	4	10	10	17	clear
26-Jul	0700	1	S	10-15	3	7	10	17	clear
27-Jul	0700	0	SSW	0-5	3	8	9.5	16	clear
28-Jul	0700	2		Calm	3	7.5	10	15	clear
29-Jul	0700	0	SSE	10-20	4	9	10	13.5	clear
30-Jul	0700	0	S	5	3	8	9	15.5	clear
31-Jul	1000	1	S	20-25	4	12	10	13	clear
01-Aug	1000	0	SE	5-10	4	9	10	11.5	clear
02-Aug	0700	0		Calm	4	8	10	11	clear
03-Aug	0700	0	N	5-10	3	15	11	9	clear
04-Aug	0700	0	East	20-30	4	Thermometer Broke		9	clear
05-Aug	0700	0	SE	0-5	3			9	clear
06-Aug	0700	0	S	1-3	3			14	silty

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Date	Time	Precipitation	Wind		Cloud Cover	Temperature (C)		Water Level (cm)	Water Clarity
			Direction	Speed (mph)		Air	Water		
07-Aug	1000	0	SE	1-3	1			14.5	clear
08-Aug	1000	0	NE	3-5	3			10	cle
09-Aug	0700	0		Calm	1/5			8.5	clear
10-Aug	0700	1	SE	5-7	4			7.5	clear
11-Aug	0700	0	SE	3-5	4			6	clear
12-Aug	0700	1	SE	5-7	4			6	clear
13-Aug	0700	0	SE	5-7	4			9.5	clear
14-Aug	1000	0		Calm	4			9	clear
15-Aug	1000	0	NW	5-10	4			9	clear
16-Aug	0700	0		Calm	5			5.5	clear
17-Aug	0700	0		Calm	5			5	clear
18-Aug	0700	0		Calm	5			3	clear
19-Aug	0700	1	SE	10-15	4			2	clear

Codes:

Precipitation:

- 0 - none
- 1 - light or intermittent rain
- 2 - continuous rain
- 3 - thundershowers

Cloud Cover:

- 1 - clear sky
- 2 - less than 50% cover
- 3 - more than 50% cover
- 4 - solid overcast (high or low)
- 5 - fog and/or smoke